AN EMISSION-LINE OBJECT FOUND IN THE ORION NEBULA*

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A small, low-temperature, high-density object has been found superimposed upon the Orion nebula. The observed spectrum suggests it is a Herbig-Haro object.

Key words: interstellar medium — diffuse nebulae — Orion nebula — emission-line object

An emission-line object has been found superimposed upon the bright nebulosity of the Orion nebula. The object was first noticed while comparing a number of plates of M42 which were taken using narrow-band interference filters with the 90-mm image tube or with the Kron electronographic camera on the 36-inch telescopes at Kitt Peak. Plates recording the fluxes of Hα, Hβ, [O III] λ5007, [O II] λ3727, [N II] λ6584 and λ5755, He I λ5876, and continuum at λ4400 show only diffuse nebular structure and easily identified bright stars. The plates of [O I] λ6300 emission have, in addition, a bright, somewhat extended object to the northwest of the Trapezium. The NASA vidicon system used by H-Y. Chiu, S. P. Maran, and R. W. Hobbs confirmed the [O I] object and was used to record [S II] λ6717 and λ6731. The latter frames indicated [S II] emission coming from the object.

Published plates by other observers show the object. In Wurm and Rosino's *Monochromatic Atlas of the Orion Nebula* (Wurm and Rosino 1959) and *Supplement* (Wurm and Rosino 1965), two plates are noteworthy. Both were taken using color glass filters: one isolating continuum about λ5200 and another isolating [S II] λ6717 and λ6731. Further, a color photograph taken by Merle Walker shows a small red nebulosity corresponding to the object. The most recent reproduction of the color photograph is found on the cover of the March 1973 issue of *Physics Today*.

Subsequently, a single low-dispersion spectrogram was obtained using the Kitt Peak 84-inch spectrograph. The plate with 300 Å mm^{-1} reciprocal dispersion extends from λ3500 to λ7300. The untrailed spectrum, in addition to the bright nebular lines, has seven emission line knots at [O I] λ6300 and λ6363, [N I] λ5200, He I λ7065, [S II] λ4068 and λ4076 (in both first and second order), [S II] λ6717 and λ6731. Comparison of the brighter nebular lines on and off the bright knot positions indicates possible detection of Hγ, Hδ, and [N II] λ5755. Upper limits were established on fluxes of [O II] λ3727, [O III] λ5007, Hα, Hβ, [N II] λ6584, He I λ5876, and continuum at λ4400 using contour maps of the individual emission lines. Fluxes relative to nebular Hβ were calculated indirectly using published fluxes for the Orion nebula (Johnson 1968).

The observed spectrum with its upper limits may be compared to the published spectrum of Herbig-Haro object No. 1 (Bohm, Perry, and Schwartz 1973). Both objects have the same bright lines and upper limits to other lines in the Orion object are compatible with HH 1.

The ratio,

$$R_1 \equiv [\mathrm{S\,II}]\ I(\lambda 6717)/I(\lambda 6731) = 0.84 \pm 0.10\ ,$$

corresponds to $N_e \sim 5 \times 10^3$ cm^{-3}. The ratio,

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$R_2 \equiv$ [S II] $[I(\lambda 4068) + I(\lambda 4076)]/[I(\lambda 6717) + (\lambda 6731)] = 0.43$ (unreddened)

$= 0.93$ (for C(Hβ) = 0.4 as implied by reddening of θ1C Orionis),

implies higher densities than does the ratio R_1. Because the ratio $R_2 = 0.93$ is in extreme disagreement with R_1, it is suggested that the object is not reddened as much as θ1C Orionis and thus, must lie in front of the nebulosity.

It is concluded that the emission-line object is a Herbig-Haro object and lies in the foreground of the Orion nebula.

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